

General

Guideline Title

The Society of Thoracic Surgeons, the Society of Cardiovascular Anesthesiologists, and the American Society of ExtraCorporeal Technology: clinical practice guidelines for cardiopulmonary bypass—temperature management during cardiopulmonary bypass.

Bibliographic Source(s)

Engelman R, Baker RA, Likosky DS, Grigore A, Dickinson TA, Shore-Lesserson L, Hammon JW, Society of Thoracic Surgeons, Society of Cardiovascular Anesthesiologists, American Society of ExtraCorporeal Technology. The Society of Thoracic Surgeons, The Society of Cardiovascular Anesthesiologists, and The American Society of ExtraCorporeal Technology: clinical practice guidelines for cardiopulmonary bypass--temperature management during cardiopulmonary bypass. *Ann Thorac Surg*. 2015 Aug;100(2):748-57. [55 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Definitions for the class of recommendations (I-III) and the level of the evidence (A-C) are provided at the end of the "Major Recommendations" field.

Optimal Site for Temperature Measurement

1. The oxygenator arterial outlet blood temperature is recommended to be used as a surrogate for cerebral temperature measurement during cardiopulmonary bypass (CPB). (Class I, Level C)
2. To accurately monitor cerebral perfusate temperature during warming, it should be assumed that the oxygenator arterial outlet blood temperature underestimates cerebral perfusate temperature. (Class I, Level C)
3. Pulmonary artery or nasopharyngeal (NP) temperature recording is reasonable for core temperature measurement. (Class IIa, Level C)

Avoidance of Hyperthermia

Surgical teams should limit arterial outlet blood temperature to less than 37°C to avoid cerebral hyperthermia. (Class I, Level C)

Peak Cooling Temperature Gradient and Cooling Rate

Temperature gradients between the arterial outlet and venous inflow on the oxygenator during CPB cooling should not exceed 10°C to avoid generation of gaseous emboli. (Class I, Level C)

Peak Warming Temperature Gradient and Rewarming Rate

1. Temperature gradients between the arterial outlet and venous inflow on the oxygenator during CPB rewarming should not exceed 10°C to avoid outgassing when warm blood is returned to the patient. (Class I, Level C)
2. Rewarming when arterial blood outlet temperature $\geq 30^{\circ}\text{C}$:
 - a. To achieve the desired temperature for separation from bypass, it is reasonable to maintain a temperature gradient between the arterial outlet and the venous inflow temperature of 4°C or less. (Class IIa, Level B)
 - b. To achieve the desired temperature for separation from bypass, it is reasonable to maintain a rewarming rate of 0.5°C/min or less. (Class IIa, Level B)
3. Rewarming when arterial blood outlet temperature is lower than 30°C: To achieve the desired temperature for separation from bypass, it is reasonable to maintain a maximal gradient of 10°C between the arterial outlet and venous inflow temperature. (Class IIa, Level C)

Optimal Temperature for Weaning From CPB

No specific recommendation for an optimal temperature for weaning from CPB may be made due to inconsistent published evidence.

Definitions

American College of Cardiology/American Heart Association: Classifications

Classification	Clinical Recommendation
Class I	Benefit >>> Risk Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment. This is classified as IIa or IIb.
Class IIa	Benefit >> Risk Weight of evidence/opinion is in favor of usefulness/efficacy.
Class IIb	Benefit \geq Risk Usefulness/efficacy is less well established by evidence/opinion.
Class III	Risk \geq Benefit Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful. This is defined as: No Benefit - Procedure/test not helpful or treatment without established proven benefit; Harm - Procedure/test/treatment leads to excess cost without benefit or is harmful.

American College of Cardiology/American Heart Association: Level of Evidence

Level of Evidence	Type of Evidence
Level A	Evidence from multiple randomized trials or meta-analyses
Level B	Evidence from single randomized trial or non-randomized studies
Level C	Evidence from expert opinion, case studies, or standard-of-care

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Diseases or conditions requiring cardiopulmonary bypass (CPB)

Guideline Category

Assessment of Therapeutic Effectiveness

Management

Treatment

Clinical Specialty

Anesthesiology

Cardiology

Thoracic Surgery

Intended Users

Advanced Practice Nurses

Physician Assistants

Physicians

Guideline Objective(s)

To provide evidence-based recommendations supporting temperature management during cardiopulmonary bypass (CPB)

Target Population

Patients undergoing cardiopulmonary bypass (CPB)

Interventions and Practices Considered

1. Site for temperature measurement
 - Oxygenator arterial outlet blood temperature
 - Pulmonary artery or nasopharyngeal temperature (for core temperature measurement)
2. Avoidance of hyperthermia (arterial outlet blood temperature less than 37°C)
3. Management of peak cooling temperature gradient and cooling rate
4. Management of peak warming temperature gradient and rewarming rate

Note: Optimal temperature for weaning from cardiopulmonary bypass (CPB) was considered but not recommended.

Major Outcomes Considered

- Neurocognitive function
- Cardiac performance
- Jugular venous oxygen hemoglobin saturation
- Morbidity/mortality
- Transfusion rate

- Intensive care unit stay

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search

The guideline developers used a systematic search of Medical Subject Heading (MeSH) terms to identify peer-reviewed articles related to temperature management in the setting of adult cardiopulmonary bypass (CPB). Candidate articles were published in PubMed between January 1, 2000, and March 31, 2014. The search revealed 768 abstracts, all of which were reviewed in duplicate by independent reviewers, with 153 abstracts selected for full paper review. To be included, each paper had to report data on each of the following: (1) optimal site for temperature monitoring, (2) avoidance of hyperthermia, (3) peak cooling temperature gradient and cooling rate, and (4) peak warming temperature gradient and rewarming rate.

According to American College of Cardiology/American Heart Association (ACC/AHA) rules, any reviewer could select an abstract for inclusion in a paper review, but at least 2 reviewers had to agree to exclude a paper. At the paper review stage, at least 2 reviewers had to agree to exclude a paper. These rules were incorporated into Guideliner reviewing software.

MeSH terms used to identify peer-reviewed articles related to temperature management in the setting of adult cardiopulmonary bypass:

("cardiopulmonary bypass" [MeSH Terms] *or* perfusion [TIAB]) *and* ("body temperature" [MeSH Terms] *or* "body temperature regulation" [MeSH Terms] *or* "rewarming" [MeSH Terms]) *and* ("humans" [MeSH Terms] *and* English [lang] *and* "adult" [MeSH Terms])

("cardiopulmonary bypass" [MeSH Terms] *or* cardiopulmonarybypass [TIAB]) *and* ("hypothermia, induced/instrumentation" [MAJR:noexp] *or* "hypothermia, induced/methods" [MAJR:noexp] *or* "body temperature" [MeSH Terms] *or* "body temperature regulation" [MeSH Terms] *or* "rewarming" [MeSH Terms]) *and* ("humans" [MeSH Terms] *and* English [lang])) *not* (("cardiopulmonary bypass" [MeSH Terms] *or* perfusion [TIAB]) *and* ("body temperature" [MeSH Terms] *or* "body temperature regulation" [MeSH Terms] *or* "rewarming" [MeSH Terms]) *and* ("humans" [MeSH Terms] *and* English [lang] *and* "adult" [MeSH Terms])).

Number of Source Documents

Two reviewers rejected 615 abstracts based on a lack of relevance, leaving 153 abstracts for full paper review. Two panel members reviewed each paper, and 82 of these papers were found not to contribute to the topic by both reviewers, a further 32 had conflicting reviews and were individually resolved, and the final 39 were considered for inclusion in the guideline.

Thirteen articles considered relevant to the topic by the authors were included to provide method, context, or additional supporting evidence for the recommendations.

See Figure 1 in the original guideline document for a flowchart of study selection.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

American College of Cardiology/American Heart Association: Level of Evidence

Level of Evidence	Type of Evidence
Level A	Evidence from multiple randomized trials or meta-analyses
Level B	Evidence from single randomized trial or non-randomized studies
Level C	Evidence from expert opinion, case studies, or standard-of-care

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Not stated

Methods Used to Formulate the Recommendations

Not stated

Description of Methods Used to Formulate the Recommendations

Not applicable

Rating Scheme for the Strength of the Recommendations

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Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Avoidance of cerebral hyperthermia in the setting of cardiopulmonary bypass (CPB) has been promoted to avoid cerebral injury.
- Avoidance of adverse effects associated with hyperthermia. One study reported an association with hyperthermia and an increased rate of mediastinitis. Another study reported that an arterial outlet temperature exceeding 37°C during CPB is an independent predictor of acute kidney injury.
- Outgassing may be prevented by maintaining a maximal 10°C gradient between the arterial blood outlet and the venous inlet blood temperature.
- According to one author, slow rewarming increases the likelihood of preventing hyperthermia.

Potential Harms

- Slowest rewarming rate was associated with improved indices of cardiac function (improved cardiac index and decreased lactate production) but was disadvantaged by longer bypass times and time to reach core temperature targets.
- The data suggest that rapid rewarming to normothermia may lead to inadvertent cerebral hyperthermia.

Qualifying Statements

Qualifying Statements

Temperature management during cardiopulmonary bypass (CPB) remains controversial, with gaps in knowledge concerning a variety of aspects of temperature management. The Institute of Medicine has identified the need to incorporate the best clinical evidence into practice. Importantly, these guidelines challenge the cardiac surgical community to conduct research to address these gaps in knowledge.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report

Categories

IOM Care Need

Getting Better

IOM Domain

Patient-centeredness

Identifying Information and Availability

Bibliographic Source(s)

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Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2015 Aug

Guideline Developer(s)

American Society of Extra-Corporeal Technology - Nonprofit Organization

Society of Cardiovascular Anesthesiologists - Medical Specialty Society

Society of Thoracic Surgeons - Medical Specialty Society

Source(s) of Funding

Society of Thoracic Surgeons

Guideline Committee

Not stated

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the [Society of Thoracic Surgeons Web site](#) .

Availability of Companion Documents

None available

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on May 6, 2016.

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